

TECHNOLOGY FOR DYSCALCULIC CHILDREN

Dr. T.NAGAVALLI,
NCERT-ERIC Principal Investigator

Mrs. P. FIDELIS PAULINE JULIET,
NCERT-ERIC Research Fellow and
Sri Sarada College of Education,
Salem -16.

INTRODUCTION

Dyscalculia refers to a range of math learning disabilities. Students with dyscalculia have difficulties in understanding what numbers mean, remembering math facts, steps to complete math problems or may have difficulty with visual-spatial concepts used in making patterns or in geometry. Dyscalculia may be related to language processing disorders which result in difficulties learning math vocabulary needed to understand math concepts and to solve more complex problems.

Someone living with Dyscalculia will have difficulty in the arenas of math reasoning, computation (addition, subtraction, multiplication and division), math memory, math writing, sequencing and math speaking, as well as visual-spatial orientation. A Dyscalculic will be challenged by both memory and retrieval difficulties, in addition to processing errors and will need to employ coping strategies his entire life. Those who suffer with the disability have been known to comment that Dyscalculia causes numbers to "slip their minds," that looking at large numbers is like trying to read an unknown language or even that it is as if their mathematics "memory banks" continually get erased after a lesson.

Children with learning disabilities are vulnerable to multiple risks, including persistence of the learning handicap, school dropout, and emotional instability; children with dyscalculia apparently face similar challenges. Therefore, treatment of dyscalculia should address the multiple facets of the disorder while focusing on educational interventions to improve study skills in general and strengthening number perception and arithmetic concepts in particular. Research in this domain indicates that students with learning disabilities can improve their overall study skills and benefit from specific techniques and assistive technology for their individual problem.

SYMPTOMS OF DYSCALCULIA

- Difficulty working with numbers

- Confused by math symbols
- Difficulty with basic facts (adding, subtracting, multiplying and dividing)
- Often will reverse or transpose numbers (36: 63)
- Difficulty with mental math
- Difficulty telling time
- Difficulty with directions (as for playing a game)
- Difficulty grasping and remembering math concepts
- Poor memory for layout of things (for example, numbers on a clock)
- Limited strategic planning skills (like used in chess)
- Relies on tangible supports such as fingers, tally marks
- Slowness in given answers to math questions
- Difficulty with estimation and approximation
- Difficulty finding different approaches to one problem
- Trouble with visualizing patterns, different parts of a math problem, or identifying critical information needed in problem solving
- History of academic failure contributing to the development of learned helplessness in mathematics

A child with dyscalculia will have average or above average intelligence but cannot achieve to that degree in the area of mathematics.

TYPES OF DYSCALCULIA

- Verbal (interpretation of verbal math terms)
- Operational (performing basic arithmetic operations)
- Lexical (reading written math terms, symbols)
- Graphical (symbol manipulation)
- Ideognostic (mental calculations)
- Practognostic (pictorial representation)

IMPORTANCE OF ASSISTIVE TECHNOLOGY FOR DYSCALCULICS

Children with disabilities experience unique learning challenges in classroom environment, **ones** which often differ from their peers. It is important when using technology in a classroom that all students will benefit from its learning outcomes.

Assistive technology can be used to help students with dyscalculia perform in the classroom.

It enables students with learning disabilities to independently learn. Assistive technology can also provide the learning disabled students with remedial and compensatory support. Categories of dyscalculic learning disabilities that affect mathematics learning include spoken language, written language, arithmetic, and reasoning. There is a variety of assistive technology that can help students with different types of dyscalculia overcome these difficulties.

A. MULTIMEDIA HELP FOR DYSCALCULIA

Children with dyscalculia lack a "number sense"---they have problems relating number symbols to real-world objects and situations. Software titles such as "Mighty Math," available for the classroom and at home, incorporates math learning into interactive video, using stories, music and visual cues to help students relate math concepts to everyday life.

a. Electronic Math Worksheets

Electronic math worksheets are delivered on a child's computer. They take the place of the traditional paper worksheets. For students with visual difficulties, the font size and style can be adjusted to suit their needs. Additionally, the sheets provide immediate feedback and some even offer homework help topics.

b. Math Software-Number Race

Dyscalculic students may have difficulties with making visual-spatial connections to numbers. Utilizing 3D and other technology, software packages like "The Number Race" rely on a multidimensional computer algorithm which allows students to see relationships between symbols and physical space. These programs are able to track problem areas and adjust levels of difficulty as a student progresses.

Math software is available to students of all ages and learning styles. Math software enables students who might not otherwise be able to participate in math activities the opportunity to construct and manipulate objects, count, sort, and combine using specially designed software programs.

c. Adapted Measuring Devices

Adapted measuring devices take a regular measuring device (like a beaker) and add large text or a voice synthesizer. Talking measuring jugs, color coded measuring cups, and big number funnel sets are all examples of types of adapted measuring devices.

d. Reading books

Most people with the learning disability are also known to be strong readers, so it should not be a surprise that books are among the tools available to Dyscalculics. These include the use of illustrated handbooks, like the helpful "Teach Yourself Visually: Algebra."

e. Babakus

The Babakus is a calculator that combines the best qualities of the western slide ruler with those of the eastern Abacus. It's part of a method for students with dyscalculia to easily work with addition, subtraction, multiplication and division. Although the focus of the method lies on those who find it difficult to deal with numbers and figures, the Babakus is an excellent proficiency training tool for those adept at counting as well. The method is highly scalable to fit each student's level of skill and understanding.

f. Computer Assisted Instruction (CAI)

CAI is particularly effective for

- Motivating students
- Providing individual instruction
- Precise monitoring for teachers.
- Drill and practice type activities in Maths

g. iPad

Applications (apps) are run on the Ipad's operating system called iOS which allows the user to control the Ipad by a multi-touch feature. MathBoard is an example of a popular app which teaches children addition, subtraction, multiplication, division, squares, cubes and square root problems. The Long Division app can be used to teach and study the long division method on iPod. It allows the user to solve a long division problem step by step and animates all the steps. In the steps the user will divide, multiply or subtract. The correct answer will fly to the

right place. If the user presses the wrong button the answer will appear above the keyboard but it will not move.

h. Quicklink Pen Elite & SuperPen Professional

- To scan a word or line of text and hear it.
- To see the definition of the word.
- To transfer text and images to PC
- Comes with dictionaries covering medicine, finance, computing, geography, science & a thesaurus.

i. Digital Pen

- **IO** Pen saves an image of pages written in a special notebook to a PC.
- Can use handwriting recognition but problems with:
 - Spelling errors
 - Terminology & equations

j. Graphics Tablet

A graphics tablet can be used to enter diagrams or equations graphically alongside a PC.

- But requires good co-ordination skills.
- Still slower than writing by hand

k. Talking calculators

Talking calculators use a voice synthesizer to tell the student which keys are being pressed. If a student often transposes numbers like 21 with 12, the calculator's assistance will help the student to identify the correct number. Additionally, the calculator will speak the answers out loud so that the student does not have to read the screen. This eliminates the risk of transposing numbers when transferring them from the screen onto paper.

- Read & Write Gold and ClaroRead provide speech-enabled software-based calculators
- Handheld talking calculators are available but expensive : £200+
 - Designed for visually impaired

l. Text-to-speech Speech Engine

- Speech engines will attempt to pronounce terminology using phonetic rules
- Can not read-back equations represented as images or in PDF files

m. Virtual Classrooms

Virtual environments are computer generated, 3D environments, which respond in real time to the activity of their users. They are 3D virtual worlds depicted on a screen where the user can navigate their way around the graphical environment using input devices, such as mice, keyboards and joysticks. This is a particularly positive aspect for users with severe learning difficulties for whom certain skills and particular training can be difficult to learn. In virtual worlds users are able to practice skills repetitively until they are ready themselves to move on comfortably with new exercises.

n. Microsoft Powerpoint 2010

Presentation software such as PowerPoint 2010 is a type of classroom technology, which is usable for both teachers and students. PowerPoint 2010 which was developed by Microsoft allows presentations to be displayed live on a computer or navigated through at the command of the presenter

o. Kurzweil 3000

It is a program designed to help dyscalculics. Students can scan in a teacher's article and the kurzweil will read the article out loud. There are options to read slower or faster, to take notes, and to highlight text.

B. MULTISENSORY HELP FOR DYSCALCULIA

Because children with dyscalculia have problems relating abstract number symbols to physical quantities and amounts, using the senses to establish a physical connection to the symbol is helpful. Programs like "TouchMath" encourage children to establish a tactile connection to number symbols by tracing, touching, or outlining them, creating a physical understanding of quantity and size relationships.

MULTISENSORY RESOURCES FOR MATHS

a. Numicon

The Numicon shapes make numbers real for children because they can see them and touch them. The shapes make odd and even numbers very apparent and they help children to understand addition, subtraction, multiplication and division. There are kits available for

groups of children and 'One to One' kits that are ideal for tutors and parents. Included in the kits are guide books with structured teaching ideas.

b. Cuisenaire Rods

The Rods come in 10 different colours and lengths representing different numbers. Young children soon get used to the colour system and older students find Cuisenaire Rods acceptable to work with too. They can be used to demonstrate things like number bonds, area, perimeter, factors, multiples, double numbers, near doubles, fractions, ratios. Cuisenaire rods can be used in conjunction with the number tracks from Numicon.

c. Nuggets

Glass nuggets are very tactile, so good for any counting exercise.

d. Plastic Peg Board & Peg Set.

Peg Boards with 100 holes are good for demonstrating percentages and fractions.

e. Base Ten or Dienes Blocks

The blocks are good for illustrating the number system and place value. They can be used for adding and subtracting numbers and concepts such as 'carrying' and 'borrowing'.

f. Stile System

This is a self checking system. The tiles are placed in a special tray, and if all the answers are right, a given pattern, which matches with the exercise from the book, will be revealed when the tray is turned over. There are three packs; 'Numbers and the Number System' (which is especially helpful for children with dyscalculia), 'Calculations' and 'Shape and Measure'. Suitable for children in Key Stage 2 and older children who need reinforcement at this level. The packs offer a systematic approach.

g. Numbershark

Numbershark is a motivating computer programme that uses 45 games to teach and reinforce numeracy and improve understanding and the use of numbers. The wide variety of carefully designed games provides many ways in which to practise at a chosen level and then to build

skills in very gradual steps. The games focus on: the number system and sequencing (very useful for dyscalculics); addition, subtraction, multiplication, division, fractions, decimals and percentages.

h. Stern's Structural Arithmetic

Stern's multi-sensory maths system was designed to develop a child's emergent number sense by building-up number knowledge and number facts in a logical and structured manner thus enabling children to think logically and reason mathematically. Stern facilitates the understanding and application of the four number operations. Since the system is based on two tangible sets of number representations, the blocks and patterns promote a clear image of number in the concrete enabling pupils to discover for themselves all of the attributes on a physical level. When numerals are introduced they correspond to the blocks and patterns by embodying the intrinsic qualities and values of those numbers.

i. Concrete models

Using concrete models is the first step in building the meaning behind mathematical concepts. These models include a variety of math manipulatives, measuring tools, building blocks, fractional boards, peg boards, chips, marbles, 2d and 3d charts and shapes, dice, straws and strips that students can handle during a lesson. Research-based studies show that students who use concrete materials develop more precise and more comprehensive mental representations, often show more motivation and on-task behavior, understand mathematical ideas and better apply these ideas to life situations.

DISADVANTAGES THAT SURROUNDS THE AREA OF TECHNOLOGY IN INDIAN CONTEXT

- Lack of knowledge among recent innovations in assistive technology among teachers and Indian educational institutions especially government sector.
- Needs time, labour and huge money to prepare or buy the aids for teaching dyscalculics.
- Lack of awareness in screening, identifying, assessing dyscalculics and providing individual remedial measures for them.

- Inadequate number of special education teachers to teach dyscalculics both in special and inclusive schools.

CONCLUSION

This paper discussed about symptoms of dyscalculia, different types dyscalculia prevailing among children and the importance of technology in the lives of dyscalculic children both at home and in classrooms. It widely discussed about the various assistive tech multisensory and multimedia. It also looked at the disadvantages that surrounds the area of technology in Indian context for the children with dyscalculia.

REFERENCES

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders*. 4th Edition. Washington, DC.
- Bird, R. (2011), *The Dyscalculia Resource Book*, Sage Publications, New Delhi 110 044.
- Edybum, D. (2003). *Measuring Assistive Technology Outcomes in Mathematics*. Journal of Special EducationTechnology , 18(4), pp.76-79.
- Emerson, J. & Babbie, P. (2010). *The Dyscalculia Assessment*, Continuum International Publishing Group, London.
- Geary, D. (2000). *Mathematical disorders: An overview for educators*. Perspectives, 26(3), 6-9.
- Ginsburg HP. (1997). *Mathematics learning disabilities: A view from developmental psychology*. Journal of Learning Disabilities, 30:20–33.
- Gordon, Neil (1992), *Children with developmental dyscalculia*, Developmental Medicine and child Neurology, 33(1), 459-463.
- Gregory, H.G. (2011). *Differentiated Instruction*, A Sage Company, California.
- Kumar, S. Praveen & Raja, B.W.D. (2011), *Special Education: Focus on Mathematical Learning Disability*, APH Publishing Corporation, New Delhi 110 002.
- Kumar, S. Praveen & Raja, B.W.D. (2008). *Minimizing Dyscalculic Problems through Visual Learning*. The Primary Teacher, 24, 87-93.
- Lewis C, Hitch GJ, Walker P. (1994). *The prevalence of specific arithmetic difficulties and specific reading difficulties in 9- to 10-year-old boys and girls*. Journal of Child Psychological Psychiatry, 35:283–292.

Mercer, Cecil D. and Susan P. Miller. (1997). *Educational Aspects of Mathematics Disabilities*. Journal of Learning Disabilities, 30(1), pp 47-56.

Mishra, R. (1991), *Development of teaching steps for handling arithmetic disabled children*. Fifth Survey of Educational research, 2, 1285.

Pearse, M. & Walton, K.M. (2011). *Teaching Numeracy: 9 Critical habits to Ignite Mathematical thinking*, A Sage Company, California.

Rao, G. Narayana. (2005), *How learning disabilities occur in a child*. Edutracks, 5(3), 10-11.

Ruth S. Shalev. (2004). *MD Developmental Dyscalculia*, Journal of Child Neurology, 19(10).

Shalev RS, Gross-Tsur V. (1993). *Developmental dyscalculia and medical assessment*. Journal of Learning Disabilities, 26:134–137.

<http://www.DYSCALCULIA-AND-HIGHER-EDUCATION.html>

faced by dyscalculic children and provide various accommodations to cater the needs of these children in an e-learning environment. Beverly Park Woolf. 2010, A Roadmap for Education Technology funded by the National Science Foundation # 0637190, The Computing Community Consortium (CCC), managed by the Computing Research Association (CRA) with a sub-award to Global Resources for Online Education, Beverly Park Woolf, P. I, pg 69.

The Trouble with Maths: A Practical Guide to Helping Learners with Numeracy Difficulties. Children with DD showed greater inter-individual variability and had weaker activation in almost the entire neuronal network for approximate calculation including the intraparietal sulcus, and the middle and inferior frontal gyrus of both hemispheres. In particular, the left intraparietal sulcus, the left inferior frontal gyrus and the right middle frontal gyrus seem to play crucial roles in correct approximate calculation, since brain activation correlated with accuracy rate in these regions. Kucian, K., Loenneker, T., Dietrich, T. et al. Impaired neural networks for approximate calculation in dyscalculic children: a functional MRI study. *Behav Brain Funct* 2, 31 (2006). <https://doi.org/10.1186/1744-9081-2-31>. Download citation.